Small Business Innovation Research/Small Business Tech Transfer

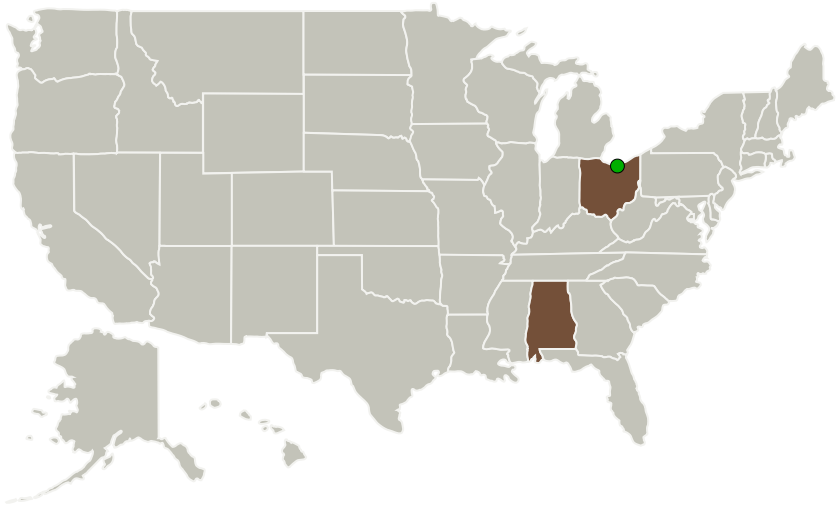
High-Efficiency Rad-Hard Ultra-Thin Si Photovoltaic Cell Technology for Space, Phase I

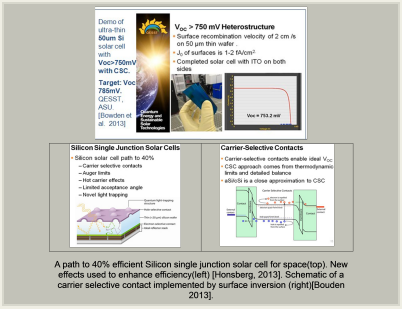
Completed Technology Project (2014 - 2014)

Project Introduction

Improvements to solar cell efficiency that is consistent with low cost, high volume fabrication techniques are critical for future NASA space missions. In this project, we propose a novel, ultra-thin (UT), Si photovoltaic cell technology that combines enhanced light trapping (LT) and absorption due to nanostructured surfaces, separation of photogenerated carriers by carrier selective contacts (CSC), and increased carrier density due to multiple exciton generation (MEG). Such solar cells have a potential to achieve the efficiencies of 40+%, while being rad-hard, lightweight, flexible, and low–cost, due to use of Si high volume techniques. CFDRC will partner with the QESST ERC center at Arizona State University (ASU) to develop and demonstrate a novel, ultra-thin, nanostructured Si photovoltaic cell technology. Phase I project will include modeling and experimental design, for a UT flexible Si based solar cell, that can achieve >25% AM0 conversion efficiency. Additionally, several approaches will be investigated to improve Si solar cell radiation hardness/tolerance. In Phase II, the physical mechanisms currently limiting light trapping, open-circuit voltage (Voc), and MEG will be identified, and addressed. The UT rad-hard cell design will be optimized (for > 36% efficiency) and a solar cell will be fabricated and presented for testing.

Primary U.S. Work Locations and Key Partners





A path to 40% efficient Silicon single junction solar cell for space(top). New effects used to enhance efficiency(left) [Honsberg, 2013]. Schematic of a carrier selective contact implemented by surface inversion (right)[Bouden 2013].

High-Efficiency Rad-Hard Ultra-Thin Si Photovoltaic Cell Technology for Space Project Image

Table of Contents

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Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Alabama	Ohio

Project Transitions

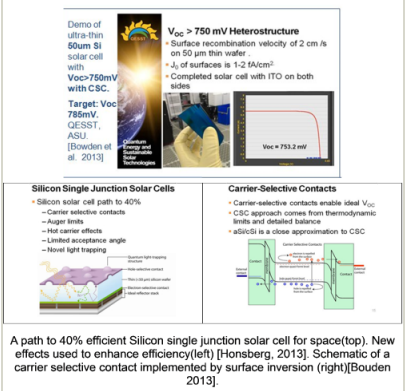
June 2014: Project Start

December 2014: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137776)*

Images



A path to 40% efficient Silicon single junction solar cell for space(top). New effects used to enhance efficiency(left) [Honsberg, 2013]. Schematic of a carrier selective contact implemented by surface inversion (right)[Bouden 2013].

Project Image
High-Efficiency Rad-Hard Ultra-Thin Si Photovoltaic Cell Technology for Space Project Image *(https://techport.nasa.gov/image/135488)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
CFD Research Corporation

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

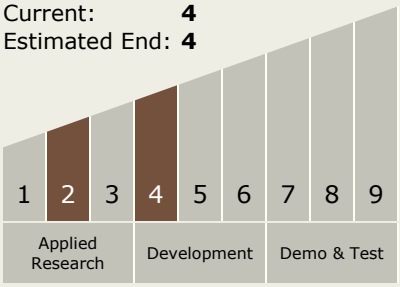
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Alex Fedoseyev

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX03 Aerospace Power and Energy Storage
  - TX03.1 Power Generation and Energy Conversion
    - TX03.1.1 Photovoltaic

Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System